

It is interesting to note that the genera of *Viverridæ* with numerous anal glands and a large circumanal pouch are African, and especially South-African, like *Hyæna brunnea*.

The extreme geographical limits of the *Viverridæ* seem to be France, Spain, Shanghai, Formosa, the Philippines, Celebes, Lombok, Madagascar, the Cape, and the north-western part of Africa—Cape Verd.

The most northern range in the continent of Asia appears to be that of *Hyæna striata* in Asia Minor<sup>1</sup>.

No species of the *Viverridæ* is so widely diffused as is *Viverricula*.

Geographically, then, as well as in some respects structurally, the *Viverridæ* (apart from the Madagascar forms) seem to divide themselves into two great sections—one Asiatic and Viverrine, the other African and Herpestine.

The *Æluroidæ* being considered as one whole, and Dr. Gray's twelve species of *Paradoxurus* and my enumeration of Cats being provisionally accepted, we have a total of 5 species of *Æluroids* in Europe, 7 species in Madagascar, 11 species in America (all Cats), 46 species in Africa, and 68 in Asia, 7 of these being common to both Africa and Asia.

Before long I hope to lay before the Society my notes on some parts of the anatomy, and especially on the osteology of the *Æluroidæ*.

2. On some Points in the Anatomy of the Indian Darter (*Plotus melanogaster*), and on the Mechanism of the Neck in the Darters (*Plotus*), in connexion with their Habits. By W. A. FORBES, B.A., Prosector to the Society.

[Received January 9, 1882.]

It is to the late Prof. Garrod that we are indebted for our knowledge of the great differences in the anatomy of the digestive organs of the American<sup>2</sup> (*Plotus ankinga*), and African<sup>3</sup> (*P. levaillanti*) Darters. The existence of such differences in birds apparently so nearly allied made it very desirable to obtain a knowledge of these parts in the other species of the genus *Plotus*.

On April 8th last, the Society obtained, by exchange from the Zoological Gardens of Calcutta, the first specimen of the Indian Darter (*Plotus melanogaster*) that it has acquired. The specimen, a

<sup>1</sup> P. de Tchihatcheff in his 'Asie Mineure' (1856), 2<sup>e</sup> partie, p. 602, reports good evidence of its existence in Asia Minor. He says:—"Je ne l'ai jamais observée à l'état vivant, mais dans plusieurs localités de la Phrygie, de la Mysie et du Pont, les habitants m'en ont positivement constaté l'existence: d'ailleurs à Selevké (littoral de la Cilicie pétrée); une dépouille de la *Hyæna striata* me fut montrée par un chasseur Arménien qui m'assura d'avoir tué l'animal dans les montagnes voisines."

<sup>2</sup> P. Z. S. 1876, pp. 335-345; Scient. Papers, pp. 334-346, pls. xviii.-xx.

<sup>3</sup> L. c. 1878, pp. 679-681; t. c. pp. 346-349.

male, lived in excellent health till December 21st last, when it died suddenly, its death apparently having been caused by some sudden shock produced by too rapid feeding, as a dozen small fishes, just swallowed, were found in its stomach. No disease whatever could be found. It is this specimen that forms the subject of the present communication.

As regards its stomach, *Plotus melanogaster* closely approaches *P. levaillanti*, the proventriculus being in the form of two quite separate patches, and the pyloric lobe being provided with a similar hair-covered conical and retractile "plug." In *P. anhinga*, it will be remembered, the proventricular glands are collected together into a special diverticulum of the stomach, whilst the pyloric lobe, though hairy internally, has no such plug. In *P. melanogaster* the two gland-patches have the form of watch-pockets, which nearly, though not quite, unite with each other superiorly. They measure 1·1 inch transversely and ·8 inch from above downwards, being thus a little larger than the similarly shaped and situated ones of *P. levaillanti*<sup>1</sup>. There is no trace of the elevated "U-shaped ridge" situated on the anterior wall of the stomach between the two patches, described and figured by Prof. Garrod in the last-named species. The gland-patches are covered, as is the rest of the interior of the stomach, by the usual yellow wrinkled "epithelium." This ceases abruptly above at the level of the upper margins of the glandular areas, where it meets the smooth and pink mucous membrane of the œsophagus. Along this line of junction, the epithelial coat is thicker and jagged, an appearance probably due to several thicknesses of this coat having been "moulted" (as we know happens in the American species) and not come clean away<sup>2</sup>.

The second, or pyloric, stomach is quite as distinct in *Plotus melanogaster* as it is in the two other species of the genus dissected. Like these, too, its pyloric half is covered internally with the peculiar hairy mat already described in these birds: the cardiac part, on the other hand, is covered by a yellow "epithelium" continuous with that of the rest of the stomach. The hairy covering forms a complete ring, thickest and best developed inferiorly—on the surface corresponding to the "greater curvature" of the Mammalian stomach—and quite surrounding the equally hairy pyloric plug. This "plug" is not a free process: it is rather a well-defined ridge, nearly cylindrical in section, attached superiorly to the wall of the stomach, but ending freely below. It, particularly towards its termination, is thickly covered with hairs of a similar character to those in the rest of the hairy region. When fully retracted, it completely fills up the centre of the hairy ring already described, the communication of the cavities of the stomach and duodenum being reduced to a narrow aperture situated below the plug, and only capable of allowing the passage of a bristle.

<sup>1</sup> In the proventricular glands being limited to distinct areas, which do not unite to form a zone, *Plotus levaillanti* and *P. melanogaster* resemble the genus *Phalacrocorax*.

<sup>2</sup> Cf. Bartlett, P. Z. S. 1881, p. 247.

It is not unusual in birds to find a small irregular nipple-like projection guarding the entrance to the pylorus; and it is, I am inclined to believe, a greatly developed condition of this structure that forms the hairy "plug" of the Old-World Darters.

In the rest of its anatomy *Plotus melanogaster* resembles in nearly every respect *P. anhinga* and *P. levaillanti*. As in the latter, there are two cæca, .2 inch long, whilst in most specimens of *P. anhinga* one only has been observed<sup>1</sup>. As in *P. anhinga*, the large intestine is peculiarly long, measuring 5.5 inches; the small intestine has a length of 30 inches. The *bursa fabricii*, I may add, in the present specimen (a ♂) had the ordinary relations of that organ to the cloaca, opening into that chamber by a small pore. There is only one carotid artery, the left, as in the two other species of *Plotus*, the genus *Pelecanus*, and *Sula leucogastra* and *S. piscator*, though not in *S. bassana*, or the other Steganopodes. The patella is only grooved, and not perforated, by the *ambiens* muscle.

The structure of the neck in *P. melanogaster* is almost identical with that of *P. anhinga*, as described and figured by Garrod. "Donitz's bridge," situated, as in the other species, on the 9th cervical vertebra, is well-ossified in the present specimen, as it is also in *P. levaillanti* and *P. novæ-hollandiæ*, though not in *P. anhinga*.

In addition to this, the similarly-situated fibrous bands—formed by a specialized part of the general cervical aponeurosis—on the 11th cervical vertebra, which are correctly figured and described (in the explanation to the plate) by Garrod<sup>2</sup> in *P. anhinga*, are also ossified, each in its median portion being converted, over a small area about the size of a hemp-seed, into bone. Through the canal thus formed on each side, the *longus colli posterior*, as well as the general mass of posterior neck-muscles, passes. On examination of *P. levaillanti*, I find these bands also ossified in that species; in *P. anhinga*, as already correctly stated by Garrod, they remain fibrous. There is no such ossification of the cervical portion of the *longus colli posterior* tendon in this species, as was observed by Garrod in *P. anhinga*; and in this respect again the African and Indian species agree, and differ from their American relative.

Prof. Garrod, in the first of his papers already referred to, has fully and accurately described the peculiar osteological and myological characters of the neck of the Darter. But, probably from never having observed these birds when feeding, he has not pointed out the connexion between this peculiar neck, with its naturally persistent "kink," of the Darters and their mode of life.

The Darters feed entirely, so far as I have been able to observe, under water. Swimming with its wings half expanded, though locomotion is effected entirely by the feet, the bird pursues his prey (small fishes) with a peculiar "darting" or jerky action of the head

<sup>1</sup> In a specimen of *Plotus anhinga* that has passed through my hands since this paper was read there was, in addition to a single cæcum of the ordinary size, a much more rudimentary one developed on the other side of the intestine.

<sup>2</sup> *L. c.* pl. xviii. fig. 2 a.

and neck, which may be compared to that of a man poisoning a spear or harpoon before throwing it. Arrived within striking-distance, the Darter suddenly transfixes, in fact bayonets, the fish on the tip of its beak with marvellous dexterity, and then immediately comes to the surface, where the fish is shaken off the beak by jerking of the head and neck (repeated till successful), thrown upwards, and swallowed, usually head first.

A study of the neck in the recently dead bird leaves little doubt

Fig. 1.

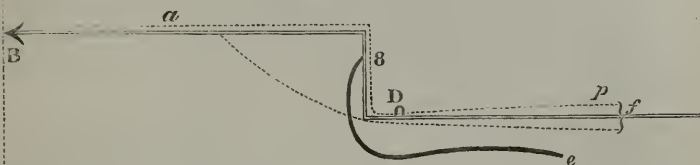


Fig. 2.

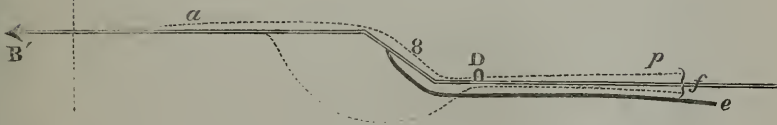


Diagram to show the mechanism of the "kink" of the neck in the Darters.

*a*, head and anterior moiety of neck (1st to 7th cervical vertebrae); *p*, posterior moiety of neck (from the 9th cervical vertebra to thorax); 8, 8th cervical vertebra; D, "Donitz's bridge," on the 9th cervical; *f*, the two flexor muscles (*vide text*); *e*, the extensor muscle (the *longus colli anterior*). In fig. 1 the flexor muscles are supposed to be acting, bending back the anterior part of the neck on the 8th cervical; in fig. 2 the extensor muscle has opened out the anterior genu formed by the 8th cervical, thereby protruding the apex of the beak (marked B in fig. 1) to B'.

as to the mechanism by which this peculiar impaling of the prey is effected. The 8th cervical vertebra is articulated, as has already been described, with the 7th in such a way that the two cannot naturally be got to lie in the same line, but form an angle, open forwards, of about  $145^\circ$ , when the two bones are stretched as far as is possible in that direction. Behind, its articulation with the 9th cervical is such as to permit it to be bent back at an angle a little greater than  $90^\circ$  with that vertebra, beyond which extent, however,

no further flexion is possible. The 8th vertebra is thus so articulated with the 7th anteriorly and the 9th posteriorly as to allow it, when the neck is flexed, to be nearly at right angles to the rest of the neck, the two portions of which, though parallel, are then at different horizons, something like the two bars of a parallel ruler (*vide* diagram, p. 211, fig. 1). When the neck is bent in this Z-shaped form, any opening out of the anterior angular bend by the action of the anterior neck-muscles causes the anterior moiety of the neck to suddenly shoot out, thus causing a corresponding protrusion of the head and beak (diagram, fig. 2). By the flexion of the 6th on the 7th, and of the 9th on the 10th, cervical vertebræ, the curve of the neck is increased—the articulations of the 8th vertebra still forming the double hinge round which motion takes place—and the impaling action correspondingly augmented. This protrusion, though only for a short distance, is so violent as to effectually “strike” the fish which the bird is pursuing.

The bending-back of the neck is effected, partly by the action of the *longus colli posterior*, partly by a special pair of closely approximated muscles, situated anteriorly along the middle line of the neck, which arise close together from the hæmapophysial spine of the 11th cervical vertebra, near its anterior articular end, and are inserted into the sides of the anterior half of the 6th cervical.

The opening-out, on the other hand, of the genu formed by the 7th and 8th cervicals—by which, as already described, the impaling action is produced—is caused by the contraction of the thoracically very powerful *longus colli anterior*. The main tendon of this is inserted on the long, backwardly-directed hæmapophysis of the 8th cervical, playing round the doubly-grooved surface of the inferior arch formed by the hæmapophyses of the 9th cervical, to which vertebra, as well as to the 10th, it gives off much smaller tendinous slips.

It is obvious that considerable advantage is gained by the action in question, the rapid protrusion of the narrow neck and head over a small space by this mechanism necessitating a less amount of exertion than would a similar movement of the whole bird over the same space, and being equally efficacious in striking the prey. The whole mechanism, it may be observed, exists in a less developed form in the neck of the Herons, Cormorants, &c.; and it requires but a slight modification of the arrangement of these parts in those birds—none of which, so far as I know, impale their prey like the Darters—to bring about the perfect adaptation of these structures to a newly acquired mode of feeding.